

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
8 February 2001 (08.02.2001)

PCT

(10) International Publication Number
WO 01/09964 A1

(51) International Patent Classification⁷: H01L 35/30, 35/32, A63H 3/38, 3/00

(74) Agents: MCNEIGHT, David, Leslie et al.; McNeight & Lawrence, Regent House, Heaton Lane, Stockport, Cheshire SK4 1BS (GB).

(21) International Application Number: PCT/GB00/02936

(22) International Filing Date: 31 July 2000 (31.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
990100260 30 July 1999 (30.07.1999) GR

(71) Applicants (for all designated States except US): INSTITUTE OF MICROELECTRONICS [GR/GR]; National Centre for Scientific Research "Demokritos", P.O. Box 60228, Aghia Paraskevi, GR-153 10 Attiki (GR). MCNEIGHT, David, Leslie [GB/GB]; McNeight & Lawrence, Regent House, Heaton Lane, Stockport, Cheshire SK4 1BS (GB).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

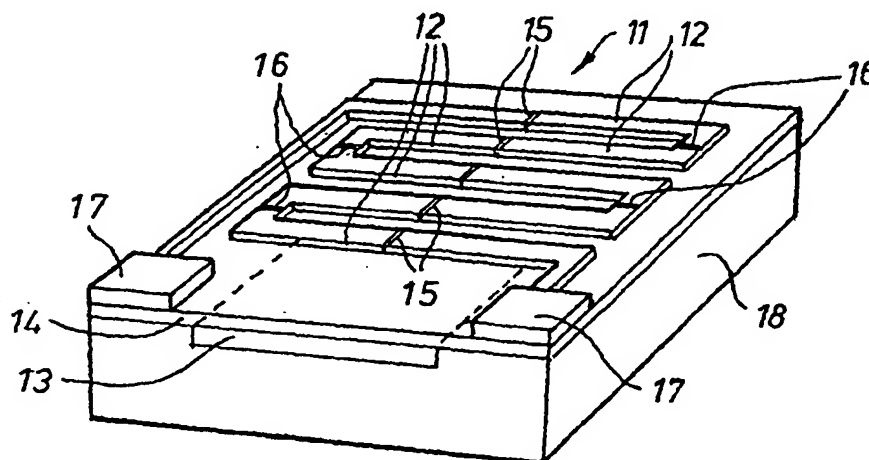
— With international search report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(71) Applicant and

(72) Inventor: NASSIOPOULOU, Androula, G. [GR/GR]; Institute of Microelectronics, National Centre for Scientific Research "Demokritos", P.O. Box 60228, Aghia Paraskevi, GR-153 10 Attiki (GR).

(54) Title: THIN FILM THERMOPILE ARRANGEMENT



(57) Abstract: There is disclosed a current generating arrangement having a plurality of thermocouples characterised in that the device comprises: a thick porous silicon layer; "hot" thermocouple contacts on said thick porous silicon layer; a bulk crystalline silicon member; and "cold" thermocouple contacts on said bulk, crystalline silicon layer.

WO 01/09964 A1

THIN FILM THERMOPILE ARRANGEMENT

This invention relates to thermopile arrangements.

A thermopile arrangement is disclosed in WO 98/50763 in a gas flow sensor based on porous silicon. The thermopile generates an electric potential in response to a temperature change induced by a gas flow, and a hot resistor is also incorporated, heated with constant power.

It is now found that thermopile arrangements can be constructed using silicon technology which can be used to generate useful quantities of electric current.

The invention comprises a current generating thermopile arrangement having a plurality of thermocouples, characterised in that the device comprises:

- a thick porous silicon layer;
- "hot" thermocouple contacts on said thick porous silicon layer;
- a bulk crystalline silicon member; and
- "cold" thermocouple contacts on said bulk, crystalline silicon layer.

The arrangement may be further characterised by having an encapsulation affording a ready heat path from an external contact such as a human finger to the hot thermocouple contacts.

The arrangement may be incorporated in a circuit with a device adapted to be powered by current from the arrangement when activated by heat contact. The device

may comprise a light emitting diode. The circuit may be incorporated in a child's toy, which can light up on finger contact.

One embodiment of a current generating thermopile arrangement according to the invention will now be described with reference to the accompanying drawings, in which:

- | | |
|----------|--|
| Figure 1 | is a perspective view of a thermocouple arrangement; |
| Figure 2 | is a view of an arrangement like Figure 1 encapsulated; and |
| Figure 3 | is a view of a circuit including an arrangement like Figure 2 and light emitting nodes in a child's toy. |

The drawings illustrate a current generating arrangement 11 having a plurality of thermocouples 12.

The arrangement comprises a crystalline silicon die 12, a thick porous silicon layer 13 and a passivation layer 14.

"Hot" thermocouple contacts 15 are on the thick porous silicon layer, "cold" thermocouple contacts 16 are on the bulk crystalline layer - the die 12.

The layers can be made by micromachining and/or deposition, the thermocouple elements and pads 17 for power take-off by deposition and/or etching in the usual way.

By approximately linking the thermocouples in series and/or parallel an arrangement having an area not much bigger than a child's fingerprint can be made to generate enough current at a suitable voltage to power a light emitting diode.

The arrangement may be encapsulated in any desired fashion save that, as seen in Figure 2, there is an area 21 above the "hot" thermocouple contacts 15 which affords a ready heat path thereto. Of course, the aim is to heat these contacts, while leaving the "cold" contacts at a lower temperature.

The arrangement 11 can be deployed in a child's toy, such as the toy cat 31 of Figure 3, the arrangement 11 being incorporated in a button 32 and being connected in a circuit 34 including two light emitting diodes, one in each eye 33. When a child presses on the button 32, the eyes 33 will light up.

Of course, the arrangement may be used also to power more serious devices. For example, to provide for back illumination for liquid crystal displays of electronic watches, calculators and organisers is - by comparison with the rest of the device - a heavy drain on battery power. By providing a device 11 in a keyboard button, enough current can be generated by finger contact to provide for screen illumination without loading the battery. Indeed sufficient power may be generated for the entire operation of a calculator or organiser, as by having a finger contact area in or by the keyboard area.

CLAIMS

1. A current generating arrangement having a plurality of thermocouples characterised in that the device comprises:
 - a thick porous silicon layer;
 - “hot” thermocouple contacts on said thick porous silicon layer;
 - a bulk crystalline silicon member; and
 - “cold” thermocouple contacts on said bulk, crystalline silicon layer.
2. An arrangement according to claim 1 characterised by having an encapsulation affording a ready heat path from an external contact such as a human finger to the hot thermocouple contacts.
3. An arrangement according to claim 2 characterised by being incorporated in a circuit with a device adapted to be powered by current from the arrangement when activated by heat contact.
4. An arrangement according to claim 3 in which the device comprises a light emitting diode.
5. An arrangement according to claim 3 and claim 4 in which the circuit is compressed in a child’s toy.

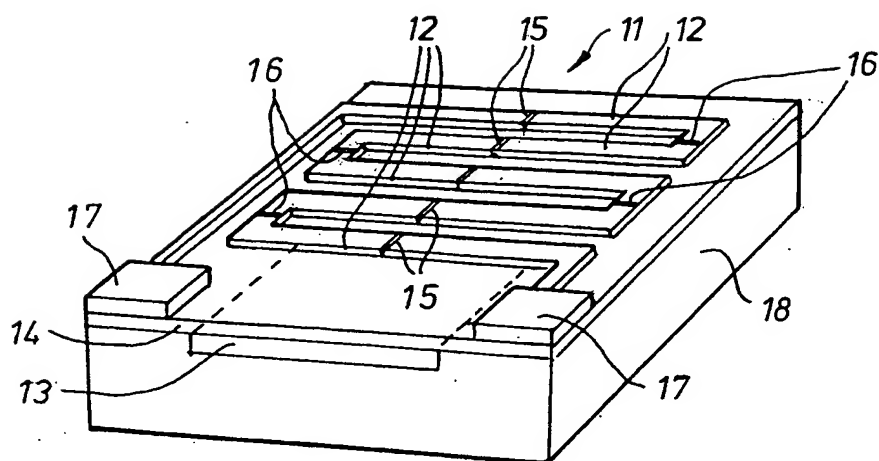


FIG. 1

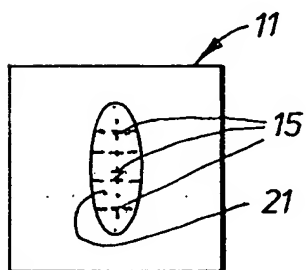


FIG. 2

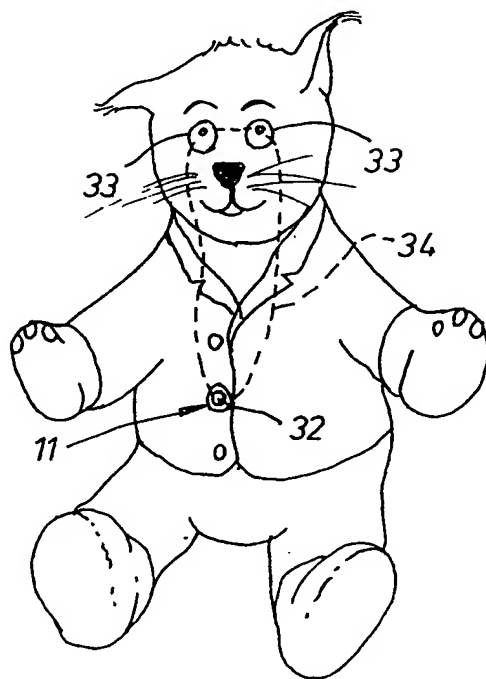


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/02936

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01L35/30 H01L35/32 A63H3/38 A63H3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L A63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 50763 A (NASSIOPOULOU ANDROULA G ;NCSR DEMOKRITOS (GR); KALTSAS GRIGORIS (G) 12 November 1998 (1998-11-12) page 1, line 7 - line 9; claim 3 ----	1
A	US 5 689 087 A (JACK MICHAEL D) 18 November 1997 (1997-11-18) column 9, line 5 - line 47; claim 22; figure 7G ----	1
A	DE 195 30 382 A (LUBETZKI JOHANNES ;MEINERS HORST (DE)) 20 February 1997 (1997-02-20) column 1, line 25 - line 31 column 1, line 50 - line 53 claim 1 ----- -/-	2,3



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

13 October 2000

Date of mailing of the international search report

20/10/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3018

Authorized officer

Ahlstedt, M

INTERNATIONAL SEARCH REPORT

Internat... Application No

PCT/GB 00/02936

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 2 957 273 A (HUGHES E.L) 25 October 1960 (1960-10-25) the whole document -----</p>	4,5

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat J Application No

PCT/GB 00/02936

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9850763 A	12-11-1998	GR 1003010 B	20-11-1998
US 5689087 A	18-11-1997	NONE	
DE 19530382 A	20-02-1997	NONE	
US 2957273 A	25-10-1960	NONE	